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Indian Standard

IS 15883 (Part 4) : 2015

(Reaffirmed 2020)

निर्माण परियोजना प्रबंधन — दिशानिर्देश

भाग 4 गुणवत्ता प्रबंधन

Construction Project Management — Guidelines

Part 4 Quality Management

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Construction Management (Including Safety in Construction) Sectional Committee, CED 29

FOREWORD

This Indian Standard (Part 4) was adopted by the Bureau of Indian Standards, after the draft finalized by the Construction Management (Including Safety in Construction) Sectional Committee had been approved by the Civil Engineering Division Council.

A construction project is an endeavour undertaken by a project team on behalf of owner/client to create and built facility suited to the defined functional stated or specified objectives. From inception to commissioning, the project goes through various distinct stages leading to progressive achievement of project objectives. Each stage involves specific inputs, processes (both technical and managerial) and deliverables. Typically, the life cycle of a project from inception to completion involves the following stages:

a) *Project appraisal* — Inception, feasibility and strategic planning;
b) *Project development* — Project brief development, planning and design, finalization of proposals, procurement strategy, construction documentation including tender drawings, construction drawings, specifications, cost estimates, bills of quantities, procurement documents;
c) *Planning for construction* — Sequencing of project components, planning tools, resource planning and time cost trade off.
d) *Tender action* — Open competitive bidding/pre-qualification of agencies, issue of tender documents, evaluation of bids, negotiation if required and award of work;
e) *Construction* — Execution, monitoring, control, work acceptance; and
f) *Commissioning and handing over* — Contractual closeout, financial closeout, defect liability commencement, facility handing over.

The distinct features of a construction project include the temporary nature of the project team involved, the evolutionary process of the project deliverables during project development stages and the unique output as the built facility. As a result of these features, unless there is efficient and effective project management, a construction project is faced with challenges of uncertainties leading to time over-runs, cost over-runs, changes in project parameters, loss of quality and inability to meet the functional objectives. While technical soundness of a proposal is an important aspect of a construction project, the management aspects, which involve techno-legal, financial and other issues, have also a significant role in the success of a project. Therefore, management functions and technical processes in a construction project need to be integrated towards achieving project objectives. Top management commitment plays an important role in harmoniously achieving these project objectives. In some of the public domain projects, it may be necessary to share relevant information with public at large through appropriate means.

To provide necessary guidance on effective construction project management, a series of standards are being developed as part of IS 15883 'Guidelines for Construction Project Management'. Part 1 General, of the standard since published as IS 15883 (Part 1) : 2009, covers general aspects of overall construction project management. This has been followed by publication of other parts as follows:

Part 2 : 2013	Time management
Part 3 : 2015	Cost management
Part 5 : 2013	Health and safety management
Part 6 : 2015	Scope management
Part 8 : 2015	Risk management

The other parts of the standard are under formulation which will cover functions such as procurement management, communication management, human resource management, sustainability management and integration management.

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Indian Standard

CONSTRUCTION PROJECT MANAGEMENT — GUIDELINES

PART 4 QUALITY MANAGEMENT

1 SCOPE

1.1 This standard (Part 4) covers guidelines for quality management aspects of construction project management.

1.2 The quality management aspects during the project formulation and appraisal stage of the project are not covered in this standard. The scope of this standard, therefore, covers the stages subsequent to the stage of approval (when a decision to implement the project including its financing is taken) till commissioning and handing over of the project.

1.3 The provisions of this standard are to be read in conjunction with IS 15883 (Part 1).

2 REFERENCES

The standards given below contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
10708 : 1985	Guide for the analysis of quality costs (*first revision*)
15883	Guidelines for construction project management
(Part 1) : 2009	General
(Part 2) : 2013	Time management
(Part 3) : 2015	Cost management
(Part 8) : 2015	Risk management
IS/ISO 9000 : 2005	Quality management systems – Fundamentals and vocabulary (*third revision*)
IS/ISO 10005 : 2005	Quality management systems – Guidelines for quality plans (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS/ISO 9000 shall apply.

4 GENERAL

4.1 Need for Quality Management

4.1.1 Every construction project has specific quality requirements which need to be met through appropriate processes. Quality management is necessary to ensure that a construction work is able to achieve its desired life span with least maintenance. It is required to provide a framework for decision making across all such processes through the responsibilities discharged within the organization and functions carried out in accordance with the requirements of project specifications, design details and contractual obligations. Quality management processes are systematically carried out during various stages of project to ensure conformance to the specified requirements.

4.1.2 Quality requirements of construction processes are developed based on relevant project specific requirements and standards. Quality management encompasses quality systems framework, construction processes and responsibilities at performer, managerial and policy levels within the organization.

4.2 Holistic View of Quality Management: Time, Cost and Quality Integration

4.2.1 Quality management processes may be grouped under the following stages of project:

a) Pre-construction stage:
   1) Project development,
   2) Planning for construction, and
   3) Tender action.
b) Construction stage.
c) Commissioning and handing over stage.

4.2.2 While the goal of this standard is to provide guidelines for quality management, the same needs to be viewed holistically and shall be considered along with other functions of construction project management such as cost, time, safety, scope, etc.

4.2.3 For quality to be ensured in a consistent manner in construction projects, it is essential that all concerned involved with the projects are quality conscious, fully aware of the quality requirements to be achieved and are able to manage these projects effectively and efficiently to meet the objective of aspects of quality, apart from time, cost, etc.

4.2.4 Quality in a project is the totality of all its characteristics, be it materials or workmanship or construction technology including mechanization. It shall involve appropriate selection and integration of these available inputs, also relating them with management of other functions like time and cost. Efficiency and quality of workmanship should be effectively planned to meet the project objective which requires need based upgrading of the technical skills at working level along with employing value based material and technology.

4.2.5 A set of interrelated quality elements used to establish and achieve the objectives of quality includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources. It includes the activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement them by means such as quality plan, quality control, quality assurance, etc within the quality system.

4.3 Organization Structure for Quality Management

4.3.1 *Review of Organization Structure*

The organization structure of project team, involving design consultants, client and other stakeholders, construction agencies and the project management teams shall be reviewed to determine nature of interfaces and interactions. Considerations may also be given to the project delivery models, such as design-bid-build; design-build; turn-key; and build, operate and transfer. It would be important to ascertain the extent and level of involvement of each stakeholder so that strategies for participation could be developed for the construction stage.

4.3.2 Quality management related responsibilities are delegated within the organization. A typical organization structure for quality management for design-bid-build model is given in Fig.1.

4.3.3 To ensure effectiveness, the quality management team shall be independent of operative functions.

4.3.4 *Quality Management Structure in Various Stages of Construction*

During the stages of a project, activities may be undertaken as follows:

a) *Pre-construction* — Quality management during this stage may be carried out in-house. The owner shall establish a quality management system.
b) *Construction* — This is carried out generally through one or more contractors. Each contractor may engage sub-contractors, although the main contractor remains responsible for the overall performance of the contract. A typical quality management organizational structure of a construction agency is included in Fig. 1. In this way, every department shall manage the quality of the processes pertaining to them. Managing quality is the process owner's responsibility. Project and the quality manager shall ensure this through audit or other interface. The quality manager shall have overall responsibility for managing a quality management system.
c) *Commissioning and handing over* — While the construction agency or agencies may hand over the project or the concerned component, owner may also be involved in commissioning and subsequent operation of the project.

The organizational structure for quality management process varies from project to project. On large and medium projects, it may be necessary to have a separate quality management team for each sub-contractor who in turn shall report to quality management team of the main construction agency. In small sized projects, this role may be merged with some other functions.

4.3.5 *Roles, Responsibility and Authority*

Organization should describe role of various participants in project, define interfaces, communication channels, responsibility delegation and authority. The role of project manager and the project team members with respect to their responsibilities within the organization as well as externally shall be delineated in relation to,

a) owner/client,
b) vendors and suppliers,
c) contractor(s), and
d) customers.

4.3.5.1 *Roles*

Project manager shall have a role in developing the project definition; undertaking the process for delivery of project within time, cost and quality requirements; and project procurement and coordination.

Project management team shall comprehend role of project sponsor in commissioning project team, project review and resolution of project conflicts.

Project management team members shall have a major role in performing various functions in project management processes. The role with respect to coordination shall be specifically highlighted including in respect of organizational interfaces with external agencies, such as consultants, contractors, suppliers, vendors and customers.

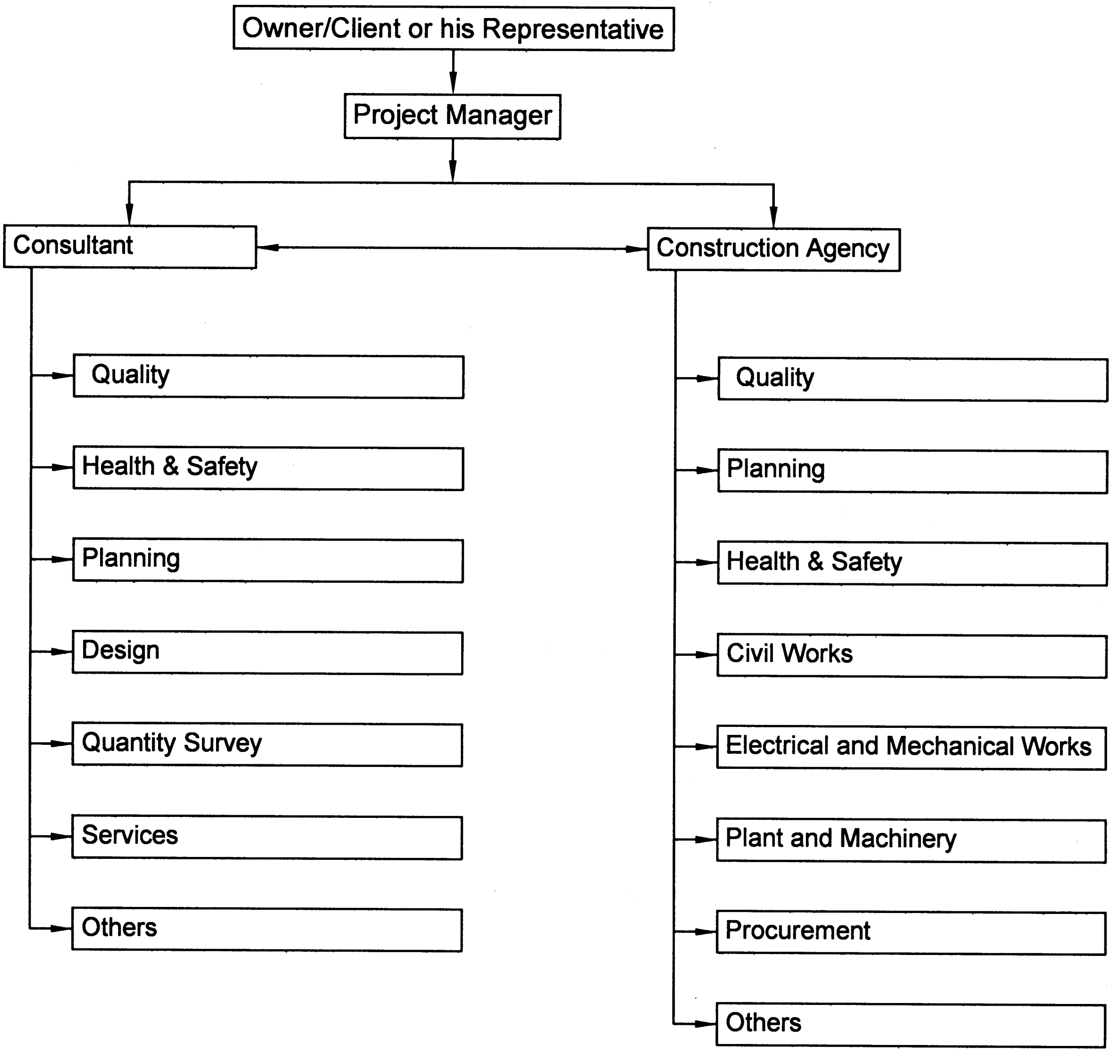

FIG. 1 TYPICAL QUALITY MANAGEMENT ORGANIZATION STRUCTURE FOR DESIGN-BID-BUILD MODEL

4.3.5.2 *Responsibilities*

Organization structure shall elaborate responsibilities of members of project management team consistent with their roles in project management. Responsibilities specific to attainment of quality objectives shall be defined.

'Process owner' responsibilities, wherein individuals perform leadership role in decision-making as well as coordination/support functions, shall be highlighted for the processes that have bearing on quality of the work performed.

4.3.5.3 *Authority*

Authority and accountability of individual project team members and their system of communication should be consistent with their role in overall quality objectives.

4.4 Methods and Processes for Quality Management

Construction quality management involves the following processes:

a) Preparation of quality policy;
b) Establishing quality management systems including preparation of construction quality management documentation and system implementation, quality/procedure manual;
c) Preparation of quality plan;
d) Management of stakeholder interfaces;
e) Developing competence through training and awareness for quality;
f) Procurement of supplies and services;
g) Defining acceptance criteria and tests;
h) Third party checks/audits for critical activity/ material;

j) Management of resources in relation to quality management;
k) Integration, clash analysis, coordination and validation;
m) Establishing infrastructure and environment for construction quality;
n) Control of non-conforming works;
p) Emergencies and disasters; and
q) Monitoring and continual improvement.

Quality management processes are developed considering the nature of project and performance requirements. Accordingly, the details and rigour of specific processes is defined. Quality management processes need to be defined in both pre-construction as well as construction phases of the project.

5 MANAGEMENT OF QUALITY IN DIFFERENT STAGES OF THE PROJECT

5.1 Pre-construction Phase

Pre-construction stages include all processes carried out prior to undertaking the construction work.

5.1.1 *Project Appraisal*

Project appraisal includes inception, feasibility and carrying out strategic planning, which have bearing on quality management during subsequent stages. As the scope of this standard does not include project appraisal stage, the same is not elaborated further.

5.1.2 *Project Development*

Project development includes identification of requirements, evolution of design (preparation of preliminary designs, drawings, cost estimates, etc), development of detailed design proposals and preparation of project management proposals. Project appraisal stage outcomes are essential inputs for project development and the same shall be reviewed before undertaking project development processes.

Following processes are essential during project development stage:

a) Establishing procedures for determination of stated and implied needs of the users and other stakeholders as inputs;
b) Defining functional and performance requirements;
c) Identifying statutory and regulatory requirements;
d) Defining scope of project development as outcomes; and
e) Conducting design review, verification and validation.

It is important to define design and development stages for effective implementation and monitoring. Project management team should ensure that the impact on quality due to any scope change is adequately assessed.

Some of the important processes/studies that have bearing on the quality during project development stage include: time and cost analysis; project risk assessment; and, energy and sustainability studies. Project development processes should take design development decisions using tools and techniques including cost benefit analysis, life cycle analysis, benchmarking, quality function deployment, statistical quality analysis, and value engineering.

Objectives of quality management team shall be consistent with those responsible for project execution. Quality considerations should, therefore, include sustainable project requirements and compliance to sustainable construction practices. It shall, therefore, be the responsibility of construction project management organization to identify such requirements and ensure that they are met through construction practices.

5.1.3 *Planning for Construction*

Construction planning considers aspects of quality planning along with other project management functions such as time management, cost management, resource management, risk management, etc. Reference shall be made to IS 15883 (Part 2) for time management, IS 15883 (Part 3) for cost management, IS 15883 (Part 8) for risk management, for detailed procedure for planning for construction stage outcomes. Resource planning and planning for enabling works have bearing on achieving quality objectives.

5.1.4 *Tender Action*

Tender documents shall be clearly and unambiguously prepared specifically in regard to all quality requirements related to the project. The agencies shall be evaluated and selected based on their ability to supply product or services in accordance with the requirements of project, defined in the tender document.

5.2 Construction Phase

5.2.1 *Requirements of Quality in Construction Stages*

Prior to the start of construction work, detailed planning shall be carried out which shall include,

a) identifying aspects of design that have bearing on quality during construction phase;
b) while planning and scheduling and budgeting various activities of the construction, making adequate time and cost allowance to carry

work in accordance with quality standards and appropriate specifications;

c) marking segmental quality plans ensuring timely delivery of quality and time;
d) reviewing the proposed method statements of various activities, identifying construction processes and their capability to achieve the desired results considering the peculiarities of the project;
e) when the risk level is unacceptable, taking additional quality control measures including revision of the work methodology so that all identified risks are addressed and quality assured;
f) planning and establishing the facilities for implementation of quality systems and procedures for assurance and control; and
g) ensuring that the appropriate enabling processes and systems that may be needed for executing the work in accordance with the quality standards, relevant statutes and standards, are put in place.

5.2.2 *Review of Pre-construction Managerial Decisions*

Pre-construction stage activities of the project shall be required to be reviewed before the project management processes are initiated for the construction stage. It is desirable to assess decisions of the briefing and feasibility stage outputs such as overall planning and construction methods affecting quality of design proposal and the construction from the point of view of function and the users, which may have bearing on construction stage.

While the project documents and proposals are reviewed for the adequacy of quality in design and constructed facility, their specific impacts on timeframes, budgets and desirability of such quality attributes, including extent of management systems proposed to be employed during construction, shall also be considered.

5.2.3 *Design and Engineering*

Design drawings, construction methodology and plans shall be reviewed to determine whether any additional risks may arise during the construction due to the features in the design or methodology.

For management of work processes, application of information technology based tools may be deployed to facilitate review of processes, comprehend complications during execution and plan appropriate construction methodologies.

5.2.4 *Quality Management System of Construction Agency*

Approach to quality and, specifically, the quality management system of the construction agency shall be studied with the aim to determine its suitability to the peculiarity of project execution based on local conditions such as weather, work culture and availability of infrastructural facilities. In the absence of an established quality management system, it is essential that the agency prepares quality plan in accordance with standard guidelines detailing out organizational responsibilities, work procedures and quality assurance formats in particular.

5.3 Commissioning and Handing Over Stage

During completion and handing over of the project, effectiveness of quality management strategies, procedures, performance measurement and management system shall be reviewed for future planning. Procedures and practices, which may be necessary during operation and maintenance phase of the project, shall be documented.

6 QUALITY MANAGEMENT

6.1 Preparation of Quality Policy

Quality policy is organizational commitment to meet the project objectives and continually improve quality management approach. Quality policy sets out mission, vision and values of the organization and its project undertakings. Quality policy takes cognizance of project requirements, stakeholder interests, technological issues and strategic planning approach while formulating and communicating high level commitments of the organization through its framework. Quality policy framework leads to establishment and review of quality objectives, which in turn determine quality tasks at the lower most level of the organization. Quality policy is contextual and needs review as the determinants undergo a change during the project or from one project to another.

Quality policy shall convey the management commitment and intent of the organization towards quality, its organizational set-up and other arrangements, including resources to ensure that the set objectives are met. It also provides a framework for establishing, maintaining and periodically reviewing quality objectives and targets.

The agencies involved in the project development such as the owner, consultant and contractor jointly or separately shall have a written statement prescribing the quality policy of the respective organization.

The policy shall be communicated to all stakeholders through display and other means. The policy shall be displayed in local language(s) which may be understood by majority at all levels who determine quality.

Organization shall ensure that the quality policy is understood by all and interpreted appropriately in the relevant context of their responsibility.

6.2 Preparation of Quality Assurance and Quality Control Manual and Project Specific Quality Plan

Management processes specifically related to quality require documentation so as to ensure that the implementation is organization-wide and the decisions are evidence based. Quality management initiatives, therefore, would be effective when implemented as a system. Organization may develop quality management system based on established standards and develop documentation that may be needed for such standards. However, irrespective of the scale of operations and nature of projects undertaken, documentation in respect of the following quality management aspects may be done for proactive process based approach to quality.

6.2.1 *Quality Plan*

The purpose of the quality plan is to outline the quality management processes of the organization and define the processes to be performed in providing independent visibility to the quality of processes being used, and outcome conforming to the desired quality standards.

Quality plans should detail out core process(es) along with delegation of responsibilities for process performers. Output of each process shall be clearly defined such that the same is verified in accordance with the specifications. Quality plan may be presented in the form of a flow chart, tabulation of processes or any other method that conveys the process flow in a comprehensive manner to its users. Quality plan should address the aspects of safety during processes, inspection and testing for work acceptance during the process as well as at end of the process. Reference should be made to IS/ISO 10005 for developing quality plans.

A project specific quality plan shall be developed by the main construction agency and submitted to owner/client and the consultants for approval. On approval, the project quality plan shall be used as a reference document for implementation, control and monitoring of quality aspects of the project by the main construction agency, owner/client, consultants and other parties concerned.

Project quality plan shall describe how the project specific quality objectives and targets shall be achieved. It shall define the road map for achieving the standards that an organization lays down for itself so that efforts can be coordinated, synergized and monitored.

Quality plan shall explain the means of establishing a positive quality consciousness and a culture of meeting quality standards at the project site. It shall identify and enumerate the control measures to mitigate the risks to the project completion arising out of quality issues so that the project processes are executed within the parameters of time, cost and scope.

Salient aspects of a typical quality plan for a construction should include, but not limited to, the following:

a) Project specific quality objectives, targets and programmes in line with quality policy;
b) Meeting legal and other requirements;
c) Resources, roles, responsibility and authority;
d) Quality requirements to be followed by sub-contractors;
e) Quality assurance and control procedure;
f) Activities and processes requiring procedures to be carried out under controlled environment/conditions;
g) Identification and control of special processes wherein output cannot be checked later (such as embedded items) and quality related problems could be noticed only at a future date;
h) Quality management requirements of processes and activities which have high risk of deviation from desired standards due to inexperience in technology or performance under challenging conditions;
j) Management of work environmental conditions which may have adverse impact on test outcome such as control room conditions, etc;
k) Ensuring the competency and awareness of the performers, managers and policy level personnel within the organization;
m) Management of special environmental conditions which may have adverse impact on outcomes, such as disasters and emergencies;
n) Continual process improvement approach;
p) Quality performance measurement, monitoring, inspection and test procedures;
q) Conduct of quality audits with defined frequency;
r) Reporting, records and investigation procedure for non-conformance control;
s) Reward and reprimand for quality performance; and
t) Checklists and formats.

This list referred to above is indicative and users of this document may include other issues that may be identified from specifications pertaining to the specific items of work or project.

6.2.2 *Quality Procedures for Construction Equipment, Plant and Machineries*

Safety, work performance and efficient operation are critical aspects of construction equipment, plant and machineries. Quality assurance procedures shall be established for construction equipment, plant and machineries to ensure that such resources are deployed effectively. Scope of quality assurance procedures shall include calibration, adherence to safety requirements and compliance to energy and environmental norms. Such quality assurance procedures should be in synchronization with the manufacturers operational guidelines.

6.2.3 *Quality Procedures for Works*

Quality procedures elaborating quality assurance and quality control requirements for construction works (including construction materials and workmanship) shall be defined. Works involving items which cannot be checked at subsequent stages such as services embedded in concrete, works which have significant failure cost and works wherein performance would be known only during actual use (such as waterproofing) shall have quality assurance procedures defined in accordance with work specifications.

6.2.3.1 *Quality control procedures*

Quality control procedures include actions arising out of results of inspections and tests. Inspection and test points may be defined as,

a) self-inspection point wherein the performer verifies the work progressively, preferably with a checklist, and maintains record;
b) hold points beyond which work may not proceed without authorization;
c) witness point wherein an opportunity is identified for inspection or test at the discretion of project manager; and
d) surveillance point identified for intermittent monitoring of progress of work.

The frequency of inspections and tests in respect of each of the categories of points identified in work areas shall be planned and actions defined based on the range of results. Results should be then used for analysis, interpretation and benchmarking of quality performance.

6.2.4 *Traceability*

Traceability of origin of material resources, performers and managers responsible for the work including the workmen, environmental conditions under which work was performed is essential for construction works since non-conformances and continual improvement activities would need analysis inputs to the work performed. In many cases, the results of quality control test would be known after a considerable time and it may be necessary to identify the work and its inputs (resources, responsibilities and conditions) for undertaking improvement and corrective actions, should the need arises.

6.2.5 *Dissemination of Quality Documents to Construction Teams*

A system of dissemination of documents and decisions to the performing and managing teams shall be established to ensure that the obsolete and unnecessary information, which could be a reason for inappropriate interpretation, is removed. A master list of various documents and their recipients shall be maintained and used for dissemination and retrieval of obsolete information. Document system shall follow norms for identifying current changes. Drawings, specifications, work instructions shall be within the ambit of document and information dissemination system.

6.3 Management of Stakeholder Interfaces

Main construction agency should ensure that the project stakeholders are identified and their interest is recognized within its scope of responsibility. Such stakeholders may include user groups, project promoters, project consultants, other contractors engaged by the client and representatives of authority having jurisdiction. Interfaces with stakeholders are essential for coordination and facilitation of matters of direct relevance to the main construction agency as well as other agencies involved in the execution of the project. Effective interfaces should include communication, exchange of information of mutual interest and coordination of respective processes. Management of interfaces shall ensure that the stakeholders' requirements are realized in full and ensure that these requirements are not conflicting with other requirements.

6.4 Developing Competence through Training and Awareness for Quality

Organization shall ensure competence of personnel performing work by continually sustaining relevance of their knowledge and skills through effective training programmes. The personnel should be aware of issues pertinent to the individual's performance needs and organizational concerns regarding quality. Organization should establish training objectives based on performance needs. Trainer should have domain knowledge and adequate practical experience to appreciate challenges involved in achieving the quality during performance of the task. Subsequent to the training, the organization should have processes to assess effectiveness of training.

6.5 Procurement of Supplies and Services

Procurement of supplies (materials and equipment) and services (consulting) are key determinants of quality of construction works. Procurement of supplies and services should consider requirements of work, risks involved and quality assurance and quality control requirements.

6.6 Management of Resources

Organization shall analyze resources that are needed for the project to meet quality standards. Comprehensive analysis of need for the resources should be based on 'resource breakdown structure' developed in conjunction with 'work breakdown structure' [*see* IS 15883 (Part 2)]. Resource analysis would also help in objective determination of requirements and thus develop procurement strategy (such as ownership *versus* renting). For effective utilization of resources, resource deployment planning should be carried out in conjunction with time planning. Resource based time planning can play a significant role to reduce resource specific risks. In absence of resource based time planning, construction schedule may not be actually realistic and hence, have adverse consequences on attaining desired quality standards.

Resource need assessment and deployment planning, if carried out at the time of contract review before undertaking the project, may avoid contractual problems and better cost planning.

Following resources require specific tools and expertise to decide on their need and to plan and manage their utilization:

a) Technical reference material;
b) Equipment, instrumentation and testing facilities;
c) Enabling works;
d) Finance; and
e) Technical and managerial competencies.

6.7 Identification of Project Peculiarities and Performance Risks

Before undertaking works, project manager is required to determine project peculiarities, such as in relation to challenges involved in attaining quality, in terms of both the technical and managerial decision making. The risk related to the performance, such as variations in working conditions affecting workmanship and material use, etc. leading to quality failure. A reference to IS 15883 (Part 8) shall be made for risk management.

Special processes are those items of works which can not be measured, monitored or verified after execution until the deficiencies are noticed during use when it is too late for any corrective action. In construction, special processes include items of work such as embedded items (reinforcements and services, etc), water proofing, foundation works and structural steel fabrication. Such special processes shall be identified which require execution under controlled conditions such as specific supervision, environmental conditions, special worker skill or use of a concerned equipment, etc. Special processes shall be validated before undertaking to prove that they are capable of generating planned results.

6.8 Integration, Clash Analysis, Coordination and Validation

Efforts should be made to ensure that the construction is well coordinated, decisions are taken by integrating inputs from various technical teams involved and analysis of the proposed work to be undertaken is carried out. All such actions should eliminate possibility of rework, interruption of work during construction and rejection.

6.8.1 *Integration of Technical Interfaces*

Technical interfaces between project participants, including consultant(s), contractor(s) and project manager, should be resolved to suit the needs of the project. It is vital that the technical inputs from various project participants are integrated. Explicit lines of communication between the project participants should ensure the manner in which technical interfaces would take place.

6.8.2 *Elimination of Redundancies and Adoption of Lean Construction Processes*

One of the objectives of the quality management is to ensure that the wastages by way of redundancies in processes are eliminated leading to efficient process approach. Lean construction approach aims to maximize value and minimize waste, which could include mistakes, working out of sequence, redundant activity and movement, delayed or premature inputs, and works that are not essential to meet the overall project requirements. Opportunities should be created to employ such management processes to make the processes inherently efficient.

6.8.3 *Coordination and Clash Analysis of Activities*

Project management responsibilities shall be planned to ensure that the works are coordinated and clash of incompatible activities is eliminated. Coordination may have to be analyzed from the point of view of work sequence during construction, interference during operations and work sequence during maintenance operations. The inputs obtained from each of the project participants shall be analyzed and work sequences defined in a coordinated manner. Appropriate software tools to create virtual physical models may be employed to finalize construction method, identify incompatibilities, clashes during work sequences. Such models may also be helpful to monitor work progress.

6.8.4 *Validation of Work Processes*

Validation refers to the performance during actual conditions. High-risk work processes must be reviewed from the point of view of the actual construction situations. Construction team involved in construction should be familiar with the processes as needed to complete the work in a safe manner. Validation may be specifically necessary where new materials or new specifications are being used without prior experience in similar works.

6.9 Establishing Infrastructure for Construction Quality

Quality management processes rely on infrastructure to achieve expected quality performance and undertake quality improvement initiatives. Such infrastructure may not be specifically defined as a part of work specifications but implied to be necessary for meeting the requisite quality standards.

6.9.1 *Provision for Inspection and Test Equipment*

Organization shall analyze quality requirements and identify appropriate inspection and test equipment and employ the same in accordance with the planned quality control procedures as mentioned in **6.2.3**. Such equipment may need appropriate handling and storage facilities as well as training to the persons concerned for their use.

6.9.2 *Quality Control Laboratories and Testing Facilities*

Quality control infrastructure of laboratories and specific testing facilities may be required for assessment of work to arrive at evidence-based decisions for quality improvement and verification of work. The competent persons in accordance with the relevant standards shall maintain such laboratories. Periodic checking and calibration of testing equipment and updating of testing procedure, standards and codes shall be ensured by the QC Manager.

6.9.3 *Environmental Conditions and Enabling Infrastructure for Work Performance*

Ventilation, illumination, humidity and temperature conditions may be specifically needed to carry out construction work in a safe and appropriate manner. In some instances these requirements may be prescribed as a part of the work specifications as well. In such cases, required environmental conditions shall be ensured. In addition, infrastructure arrangements may also be needed for undertaking the work involving use of such as scaffolds, barricades, safety nets, safe walkways with protection from falling debris, etc. Such enabling infrastructure shall be identified; appropriately designed to meet the structural, environmental and statutory requirements; and provided.

6.9.4 *Training Facilities*

Training is an integral part of construction quality management. Facilities for training must be provided at work sites. These could include arrangements for demonstration of work procedures on mock-ups, handling and use of apparatus and equipment to be used, conference facility with suitable training aids, etc.

6.10 Control of Non-conforming Works, Emergencies and Disasters

Quality management guidelines aim to ensure conformance to requirements. However, non-conformities may occur due to risks in performance, including workmanship. Non-conformities should be systematically analyzed to improve effectiveness of processes. Certain non-conformances lead to emergency situations or disasters, which need planning to limit the extent of damage to works as well as the persons involved. Following procedures shall be employed to manage non-conformities, emergencies and disasters.

6.10.1 *Identification, Segregation and Disposal of Non-conforming Works*

Non-conforming works shall be identified and segregated as soon as they occur so as to avoid inadvertent carrying out further construction activities. Non-conformities need to be traced to the origin of their cause. Therefore, the competent person under defined authorization should examine and analyze such works and propose in regard to the following:

a) Re-work, acceptance with concession or disposal; and
b) Process improvement to ensure non-occurrence of such non-conformities.

The authority that approved the work originally shall duly evaluate the proposal so recommended.

6.10.2 *Review and Management of Risks for Emergencies and Disasters*

Construction project should be assessed for the anticipated risks leading to emergencies and disasters. Failures of scaffolds, collapse of excavation, failure of shuttering, collapse of walls, failures during hoisting operations, etc, are some of the typical high vulnerability construction procedures known to have led to emergencies and disasters. Hazard potential of such high-risk construction operations should be based on assessment of probability of occurrence and its damage potential. Project management organization should develop understanding of risk and consequent hazard potential based on past experiences. Reference shall be made to IS 15883 (Part 8) for this purpose.

6.10.3 *Planning for Management Response to Emergencies and Disasters*

Risk response should take into consideration the hazard potential of construction processes. Risk response should aim to,

a) explore risk avoidance;
b) risk transfer; and
c) limit extent of damage under prevailing risks.

6.10.4 *Prevention and Corrective Actions*

Subsequent to identification and segregation of non-conformities, preventive and corrective actions should be taken to improve processes. Such preventive and corrective actions should be specifically monitored for their effectiveness and results of improved processes compared with the anticipated improvements. Until preventive and corrective actions yield the desired results, they shall continue to be under direct designated managerial responsibility.

6.11 Monitoring and Continual Improvement

Continual improvement is an inherent characteristic of quality management. Continual improvement process is centered on monitoring of efficiency and effectiveness of work procedures. Monitoring of works and processes encompasses,

a) measurement of conformance to quality as process output;
b) analysis of conformance to quality measurement; and
c) interpretation of measurement and analysis in work/project context.

6.11.1 *Quality Performance Indicators and Acceptance Criteria*

Quality performance indicators should be identified relevant to the work and customer requirements. Accordingly, acceptance criteria should be defined considering customer needs and cost, and in conformance to national standards and accepted engineering practices.

6.11.2 *Statistical Analysis of Construction Process Outputs*

Consistency of conformance to quality requirements as process output should be measured and statistically analyzed to determine variance, consistency pattern, frequency of occurrence of non-conformances, etc.

6.11.3 *Quality Auditing*

Quality audit is a systematic and independent examination to determine whether quality activities and related results comply with planned requirements and whether these arrangements are implemented effectively and are suitable to achieve the objectives. Quality audit may be first party, second party or third party.

Quality audits should aim to determine,

a) process efficiency and effectiveness;
b) comprehension of quality objectives by performers and managers;
c) effectiveness of corrective and preventive measures;
d) promotion of quality culture: and
e) non-conformities, responsibilities and remedial measures.

Quality audit criteria, scope, frequency and procedures are defined considering nature of project ensuring objectivity and impartiality. Quality audit shall be conducted during pre-construction and construction stages of the project. During project development stage, quality audit shall focus on the project development process as well as effectiveness of the processes in achieving the stakeholder satisfaction. Design reviews can be audited to ascertain the extent of satisfaction of the stakeholders the processes are able to achieve. Quality audit should identify areas of improvement of project development to improve the efficiency and effectiveness. During project development stage, project management proposals should be audited to ascertain for their adequacy in effectively meeting the project goals.

During planning for construction stage, quality audit should focus on the process audit for planning for construction.

During construction, the scope of quality audit shall include construction management process audit based on quality assurance and quality control results. A systematic study and examination of documents related to quality control should be done during the construction phase to establish that the inputs during construction process and the workmanship of work done conform to the prescribed specifications and are of acceptable standards. If it does not conform, it need to identify whether rejection and/or rectification or any remedial measures are needed.

Broadly, quality audit team should focus on the following:

1) Visual inspection or inspection with use of

suitable instruments, of the works completed and/or under progress, perusal of photographic record, if any;

2) Perusal of quality control and quality assurance (QC/QA) documentation, and all test records and registers;
3) Inspection of testing laboratories, adequacy of testing facilities, and reliability thereof and general competence of laboratory staff;
4) Contractor's workforce and construction equipment deployed at works and assessing the adequacy thereof in respect of the quality related aspects;
5) Whether any corrective/preventive actions are needed and being implemented; and
6) Any other relevant aspect of quality assurance.

Management responsibilities and follow up actions are crucial to effectiveness of quality audits.

6.11.4 *Quality Cost Analysis*

Construction projects have a major challenge to control wastages and handle quality failures (reworks, rejections and acceptance at lower quality, etc). Quality cost is an effective tool for assessing performance of quality management activities. Process effectiveness, as cost of quality, should be determined on the basis of,

a) cost of conformance and cost of non-conformance; and
b) preventive, appraisal and failure cost.

Quality cost analysis may be carried out during pre-construction as well as construction stage processes. The analysis can be carried out for the process efficiency leading to intangible output such as design and also tangible outputs such as products of items of work executed. IS 10708 may be referred for further application.

6.11.5 *Continual Quality Improvement Benchmarks*

Continual quality improvement should be planned based on the measurement of performance using quality audits, quality cost analysis and statistical analysis of measurements. Continual quality improvement decisions should be fact based so that the effectiveness of such continual improvement benchmarks could be evaluated.

6.11.6 *Quality Improvement Interventions*

Quality improvements interventions should be undertaken involving all project participants concerned. It is important that the concerned project participants have a positive attitude towards the interventions else their effectiveness will be compromised. If required, the aspect of human behaviour may need to be addressed while undertaking quality improvement interventions.

6.11.7 *Organizational Process Assets Update on Quality*

All relevant documents, which provide information on performance of organization in achieving, desired quality shall be compiled after the project closure. The aim is to learn from the experiences and create process assets for future use.

7 PROMOTING A QUALITY CULTURE

The owner/client, consultant and construction agency shall jointly endeavour to promote a positive quality culture at the project.

Top management of the organizations should exhibit a visible management commitment and felt leadership towards quality. This shall be achieved by exhibiting a motivational and inspirational behaviour towards quality.

The top management should clearly communicate that it considers quality as core value and it shall not allow it to get compromised. Such messages when it reach down the level in the organization enable to create a consciousness towards quality and appropriate attitude.

8 PERFORMANCE APPRAISAL AND RECOGNITION

Achievement of quality objectives is satisfaction to all, including the performers. Appraisal of achievement, and preferably exceeding, such objectives is the basic need for participatory management and a significant source of intrinsic reward for the team members. A systematic appraisal is fundamental to setting the benchmarks for the quality performance. Organization should endeavour to suitably reward success of achieving quality objectives for motivation.

9 INTEGRATION WITH OTHER MANAGEMENT SYSTEM

In order to enhance the efficiency and effectiveness of the organization, the quality management system established and implemented at the project shall be in coherence with other management systems implemented for the project.

10 POST CONSTRUCTION REVIEW AND DOCUMENTATION

Post construction review shall be done analyzing the quality related important instances and their impact including learning from the non-conformities to avoid their repetitions and shall be documented and preserved for later reference.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Construction Management (Including Safety in Construction) Sectional Committee, CED 29

Organization	*Representative(s)*
In personal capacity (*103, Charak Sadan, Vikaspuri, New Delhi*)	Shri P. Krishnan (***Chairman***)
Aecom India Private Limited, Noida	Representative
Airports Authority of India, New Delhi	Shri Pradeep Kumar Shri S. Sreekumar (*Alternate*)
Builders' Association of India, Mumbai	Shri H. S. Pasricha Shri Sanjay Soni (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	Dr Shailesh Kumar Agrawal Shri Pankaj Gupta (*Alternate*)
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Central Public Works Department, New Delhi	Shri B. B. Dhar Shri Sanjeev Rastogi (*Alternate*)
Construction Industry Development Council, New Delhi	Shri P. R. Swarup Shri Ravi Jain (*Alternate*)
Creative Design Consultants and Engineers (P) Ltd, Ghaziabad	Shri Aman Deep
Delhi Development Authority, New Delhi	Shri Ashok Khurana Chief Engineer (HQ) (*Alternate*)
Delhi Metro Railway Corporation, New Delhi	Shri Daljeet Singh
Delhi Tourism and Transportation Development Corporation, New Delhi	Shri Jose Kurian Shri Vivek Bansal (*Alternate*)
EH and S Cares, New Delhi	Shri A. K. Tripathi
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Hindustan Construction Company Limited, New Delhi	Shri D. M. Kudtarkar Shri Rajendra Sawhney (*Alternate*)
Hindustan Prefab Limited, New Delhi	Chairman and Managing Director Shri Rajeev Chaudhary (*Alternate*)
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Indian Institute of Technology, New Delhi	Prof B. Bhattacharjee Dr K. N. Jha (*Alternate*)
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Military Engineer Services, Engineer-in-Chief's Branch, Army Headquarters, New Delhi	Brig Manoj Kumar Col M. K. Prasad (*Alternate*)
Ministry of Statistics and Programme Implementation, New Delhi	Dr Devendra Verma Shri R. Rajesh (*Alternate*)
National Buildings Construction Corporation Limited, New Delhi	Shri Rajendra Chaudhari Shri H. K. Dhawan (*Alternate*)
National Highways Authority of India, New Delhi	Shri R. K. Gandhi Shri R. N. Chowdhary (*Alternate*)
National Institute of Construction Management and Research, Mumbai	Dr Anil Agarwal
Nirman Vikas Anusandhan Sansthan, Raipur	Shri Sanjeev Kasliwal Shri Amarjeet Singh (*Alternate*)

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PHD Chamber of Commerce and Industry, New Delhi	Dr Ranjeet Mehta
Planning Commission, New Delhi	SHRI S. S. Ganapathy
PMI Organization Centre Pvt Ltd, Mumbai	Shrimati Leena Gupte Samant Shri Tejas Sura (*Alternate*)
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(*Continued from Second cover*)

This standard (Part 4) on quality management has been formulated with the aim to provide guidelines for ensuring that the project quality requirements are achieved during construction process with minimum rework. Some of the important aspects that this standard covers include: overview of quality pre-requisites during various project development stages, requirements for quality management, work procedures that determine quality assurance, infrastructure needs for construction quality and management of non-conforming works.

The guidelines may be applicable in general to all construction projects. However for smaller projects, the applicability of various provisions may be decided appropriately by the parties concerned.

The composition of the Committee responsible for formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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